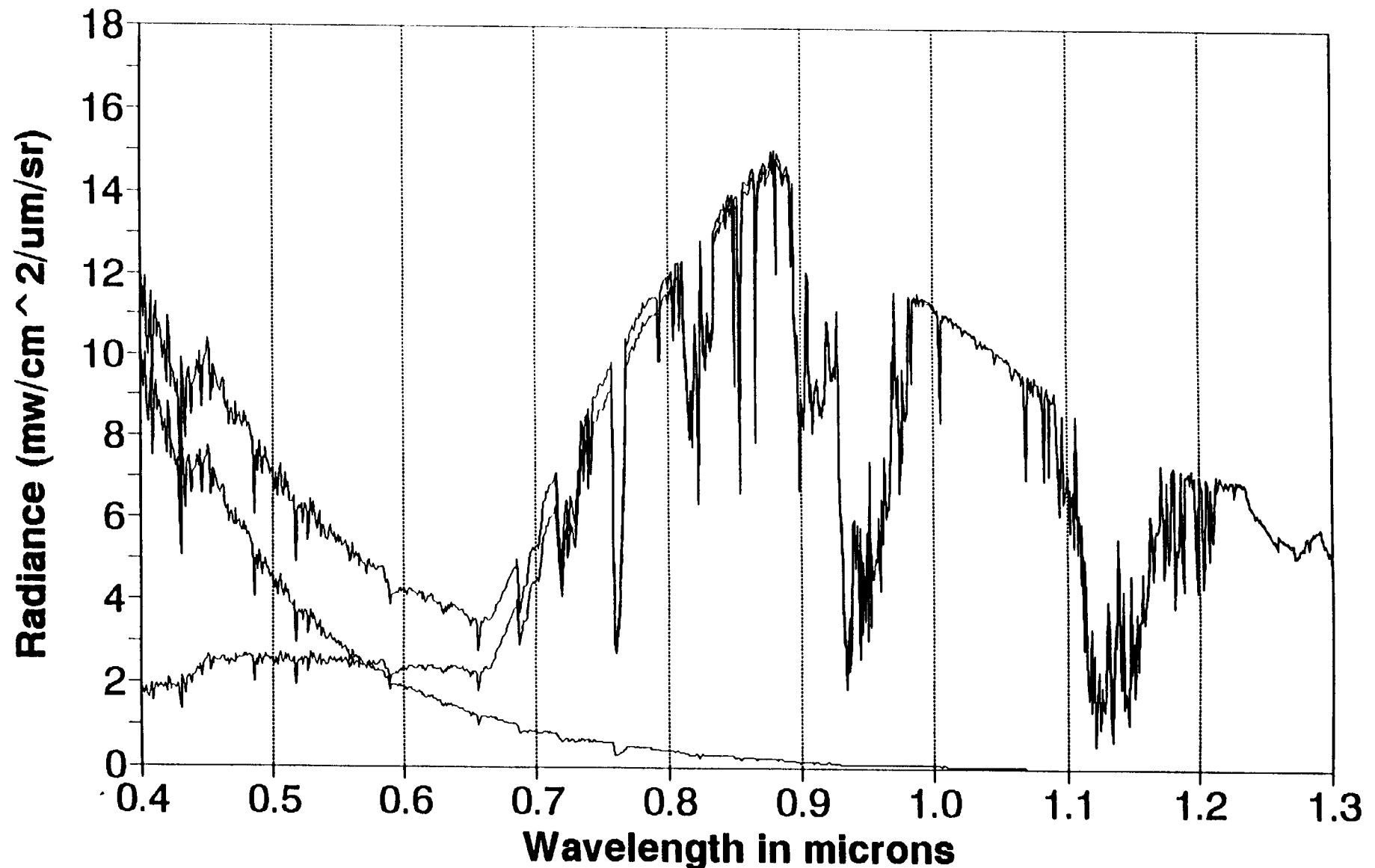


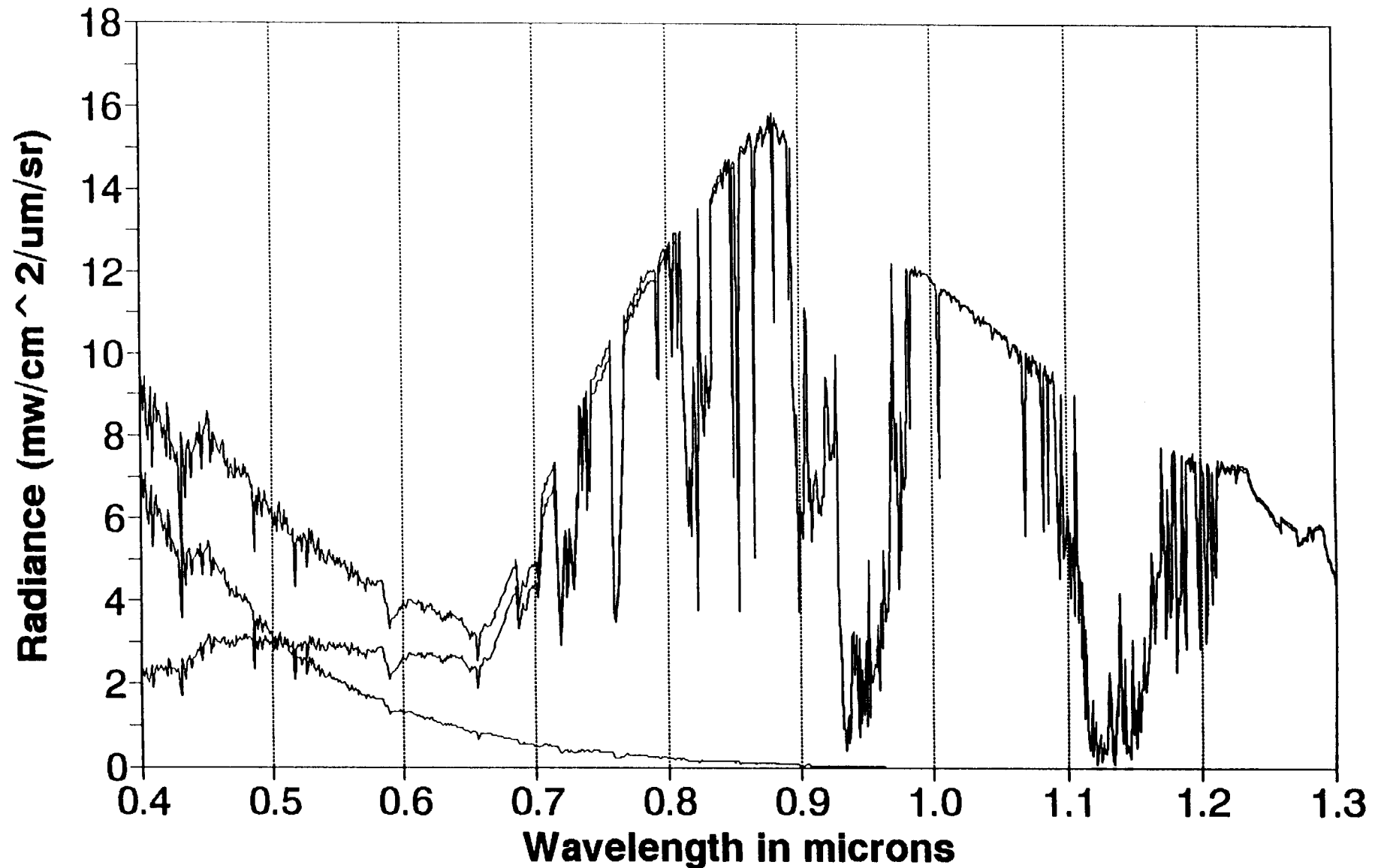
Radiance at Top of Atmosphere

over green vegetation, $Z(\text{sat}) = 55$



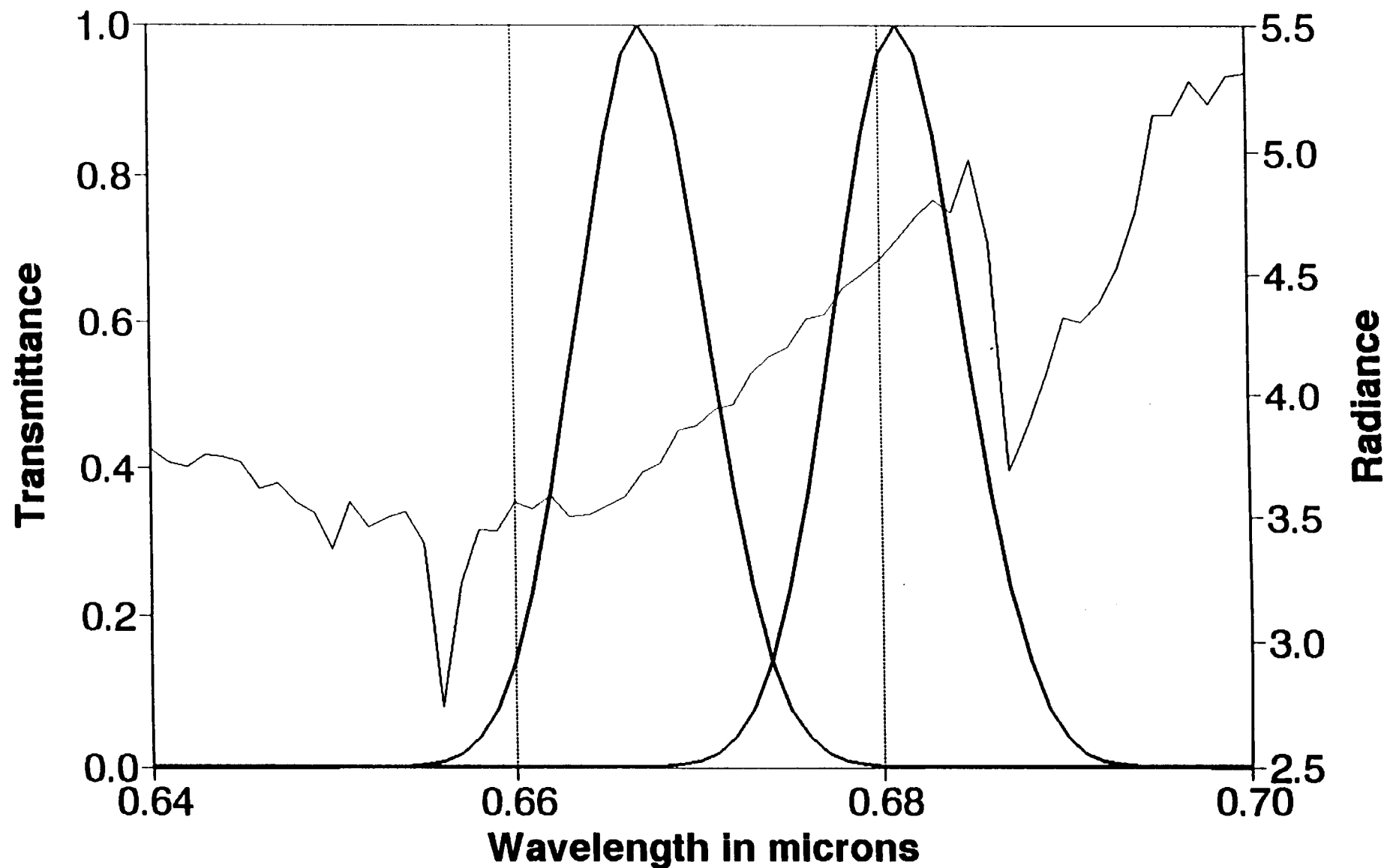
Radiance at Top of Atmosphere

over green vegetation, $Z(\text{sat}) = 0$



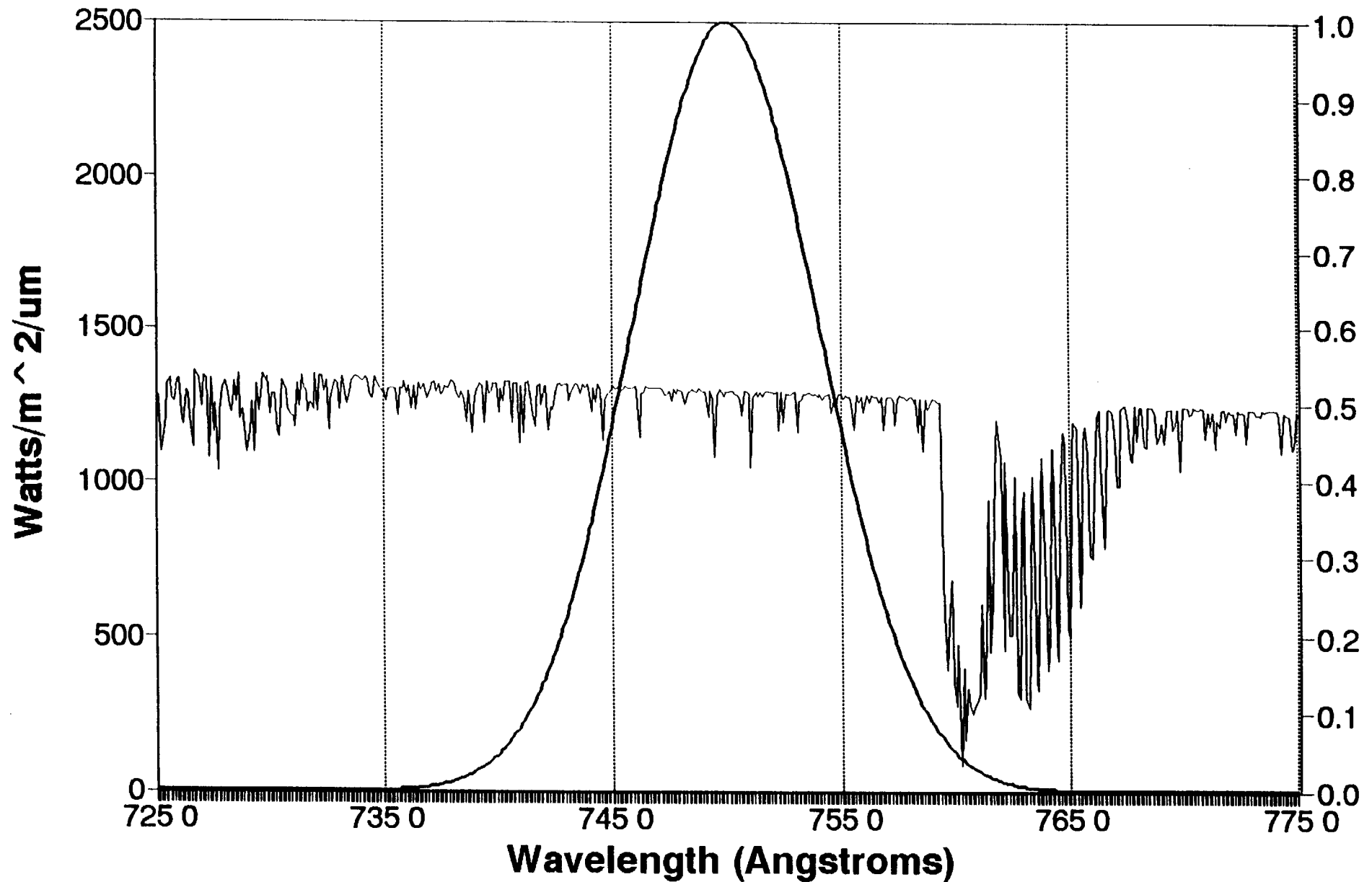
Filter Transmittances

bands 13 and 14



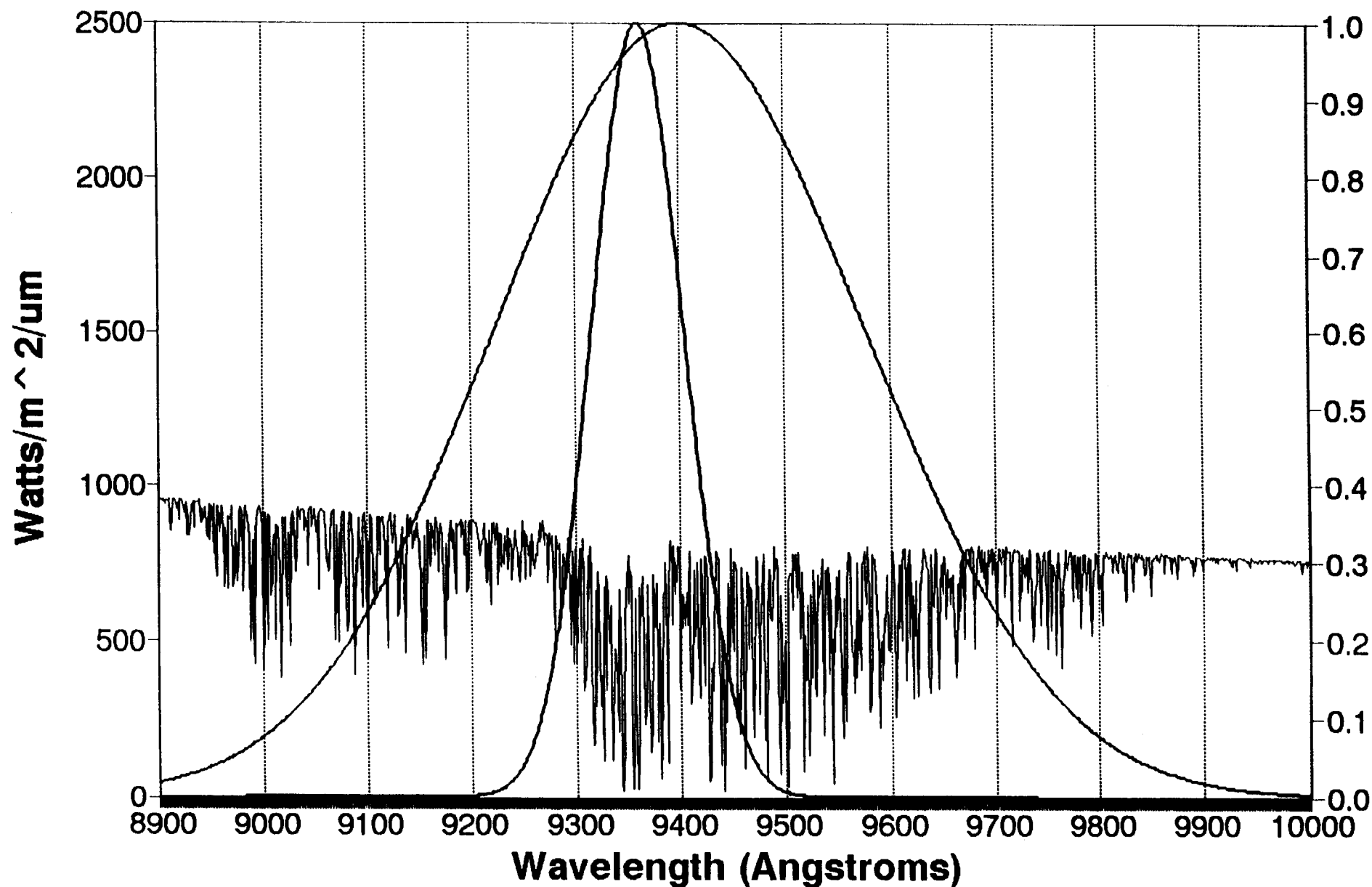
Extra-terrestrial Solar Spectrum

with MODIS band 15



Extra-terrestrial Solar Spectrum

with MODIS bands 18 and 19



MODIS/MERIS CRITIQUE

Some capabilities of MODIS and MERIS were investigated. The opinions rendered below are based upon the latest information (or lack of it) available on MERIS, and may not reflect the latest thinking on MERIS design. Two relational aspects of MODIS and MERIS are addressed: 1) the instrument performance, and 2) the research potential.

INSTRUMENT PERFORMANCE

A comparison of MODIS-N with the latest MERIS design reveals numerous differences. MODIS-N is a 36 band imaging spectroradiometer with bands from 0.4 to 14.2 micrometers and spatial resolutions of 250, 500, and 1,000 meters at nadir. MERIS is an imaging spectrometer capable of downlinking 15 bands in the spectral region from 0.4 to 1.05 micrometers with spatial resolutions of 250 of 1,000 meters at nadir. The MODIS-N swath results in near one-day global coverage while MERIS requires 3 days to image the Earth.

MODIS-N utilizes a single set of imaging optics, a crosstrack scan mirror and 470 detector elements to generate a spatially registered radiometrically calibrated 11 mb/sec data stream. MERIS consists of 6 spatially overlapping pushbroom spectrometers with a total of 2.66 million detector elements and a maximum data output of 26.3 mb/sec (15 bands @ 250 meters).

MODIS-N includes onboard spatial, spectral, and radiometric calibration subsystems with numerous redundant features whereas MERIS has only a non-redundant on-board spectral (radiometric?) calibration system that places solar diffusers in front of the 2 end spectrometers. The 4 middle spectrometers are calibrated by transferring the end system scale via a reference signal from a solar illuminated integrating sphere.

The MODIS-N pointing knowledge requirement (including the spacecraft) is 480 meters. The corresponding MERIS figure is 2,000 meters.

From its inception, MODIS-N was designed as a global change radiometer capable of addressing a broad class of interdisciplinary problems whereas the MERIS design is primarily aimed at bio-optical oceanography with land surface processes and atmospheric investigations being of secondary importance.

MERIS' "programmability" capability was shown to be very misleading in Nov 91. There appeared the need to make the infamous binary decision before launch as to what bands would be ocean range, and which would be atmosphere-land. High and low dynamic range bands cannot overlap spectrally. Specific bands with each capability for recorded global data are hardwired. With MODIS, there are five bands, including all the land high resolution bands, which overlap ocean bands.

SCIENCE CONSIDERATIONS

1. REMOTE SENSING OF AEROSOL

It is very important to have MODIS and MISR on the same platform.

Explanation: Algorithms for remote sensing of tropospheric aerosol are based on the observation by MISR simultaneously in several view directions, and on MODIS observations in wide spectral range using several inversion techniques that differ from ocean to dry land areas and to moist land areas. MODIS has daily coverage while MISR has a coverage of roughly 9 days. Aerosol properties derived from MISR data will be used to tune and validate the MODIS techniques for aerosol remote sensing, while MODIS will generate daily aerosol products of optical thickness, size distribution and single scattering albedo. Without the simultaneous input from MISR, the quality of the MODIS aerosol products will be substantially reduced. MERIS won't have this synergy with an instrument like MISR.

2. REMOTE SENSING OF CLOUDS

It is very important to have MODIS, CERES and MISR on the same platform.

Explanation: CERES needs MODIS as a high resolution imager of the cloud properties, for its detailed analysis of the clouds and earth radiation budget.

The observation by MISR in several view directions simultaneously can provide information on the cloud's three dimensional structure. If MODIS is on the same platforms, the same clouds can be identified from the MODIS image and the relation between the MODIS cloud products (that are based on the MODIS wide spectral range and daily coverage) that originally will assume a plane parallel cloud model can be tested and modified. It is critically important to estimate the effect of cloud morphology on the MODIS cloud products, and it can be done only having MODIS and MISR on the same platform.

3. REMOTE SENSING OF THE LAND

It is very important to have MODIS, and MISR on the same platform to evaluate the vegetation angular and temporal reflection properties. It is also important to have the same land spectral bands on the AM and PM platform to evaluate the vegetation daily cycle.

Explanation: The observation by MISR in several view directions simultaneously can provide information on the vegetation and soils angular reflectance. This can be used with vegetation models to derive the vegetation and soil intrinsic parameters (leaf area index, single scattering albedo etc.). But these observation won't occur very often (9 day MISR cycle, clouds, other MISR priorities). MODIS will generate products with vegetation dynamics using the visible near IR and IR bands. Having the two on the same platform will enable to obtain detailed information from MISR which will be combined with the time series from MODIS.

4. REMOTE SENSING OF THE OCEANS

MODIS T was dropped with assurance that there would be two MODIS N instruments to provide coverage frequency. SeaWiFS follow-on is to fill gap between SeaWiFS and 2 MODIS-Ns. A single MERIS would suffice for the visible ocean coverage of the first MODIS N PROVIDED THAT 1) the dynamic ranges for ocean bands are set for ocean saturation radiances, and 2) ocean coverage and settings are provided routinely over coastal zones when swaths overlap land. Note that this will preclude significant land and atmospheric use of MERIS. Note also that there are no plans to continue MERIS beyond the first flight. There may also be a gap before MODIS appears on the second AM EOS platform.

5. OTHER UNCERTAINTIES REGARDING MERIS

It is not clear how MERIS is going to provide simultaneous information on oceans and land. Main problem may occur in the green (0.55 μm) and red (0.65 μm) where both ocean color and land vegetation need spectral bands. The problem is that each one needs a different gain setting. Even if it is possible to change the gain setting during flight, in the very important coastal zones, ocean and land can be in the same swath, forcing probably the elimination of useful information from one of them.

Co-registration of ATSR and MERIS data will require significant extra effort, and not be as high a spatial resolution as from MODIS. Calibration monitoring is not as good as for MODIS, and may possibly impact trend detection over the mission life.

Data from many X-band stations around the world will have to be pooled to make global products at high (250 m) spatial resolution. Presently there are significant gaps in such X-band station coverage, and there is still the gain-setting (saturation) problem for atmosphere versus land versus oceans.

Presently there is no mechanism whereby US scientists may serve on MERIS science teams. Insight of instrument operation, and access to data, are major concerns.